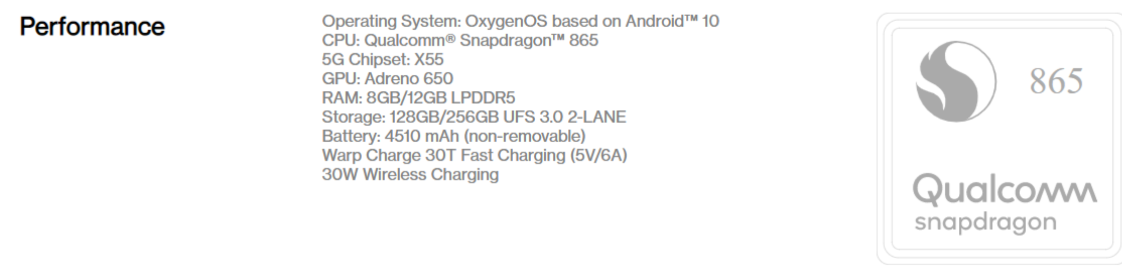
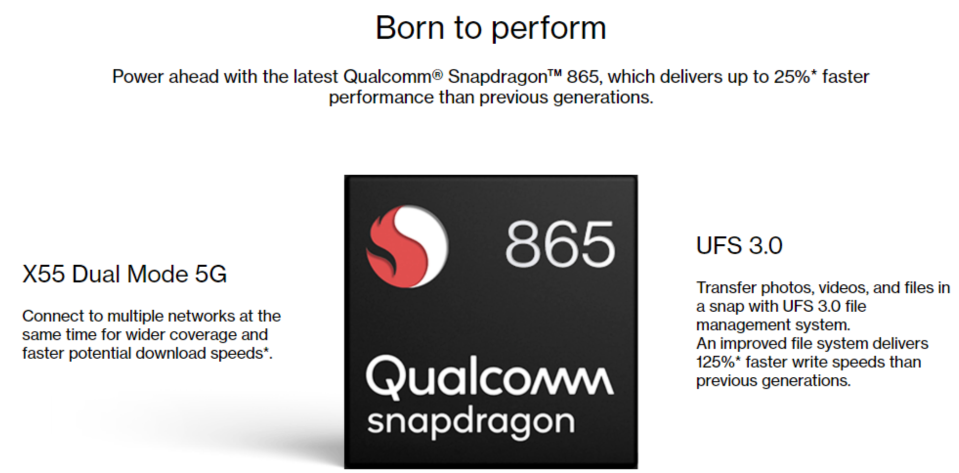
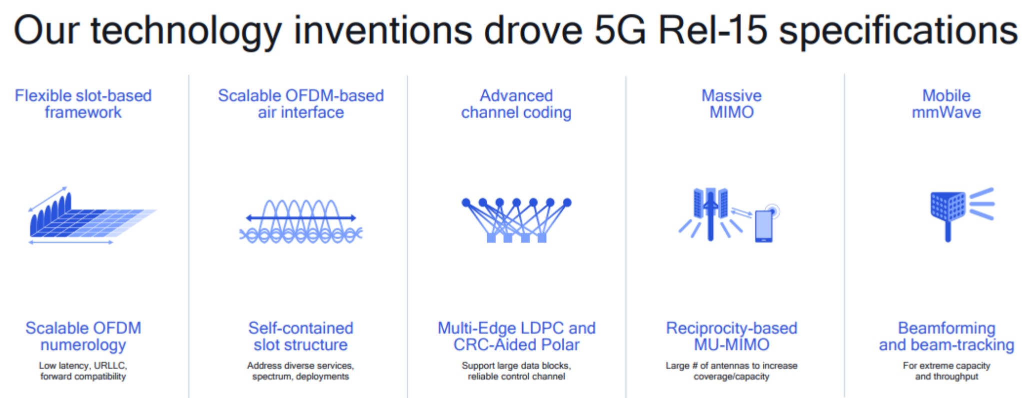
Exhibit 2

US9231746B2	Specification Support	OnePlus 8 and 8 Pro (The accused products)
1Pre. A method of transmitting channel information for link adaptation of a radio channel in a wireless network, the method comprising:	The **channel information describes momentary characteristics of the channel**. In LTE, **the channel information is also referred to as Channel State Information (CSI). The channel information may comprise Channel Quality Indicator (CQI).** [Col.1, line 61-64] Furthermore, the **channel information may comprise a Precoding Matrix Indicator (PMI).** [Col.2, line 1-2] The **channel information CI may be used by the base station 15 for link**	The accused products practise a method of transmitting channel information for link adaptation of a radio channel in a wireless network, the method comprising: OnePlus 8 series mobile devices (i.e. OnePlus 8 Pro and OnePlus 8) are the latest releases of OnePlus that support 5G in their devices. The Mobile devices comprises of 5G supported Qualcomm Snapdragon 865 processor along with the Qualcomm Snapdragon X55 5G Modem-RF system for transmission of signals (i.e. Channel Information), as shown in Fig. 2 and Fig. 3. For representative purpose, specification from OnePlus 8 pro model is shown in Fig. 1 **Citation 1: OnePlus 8 Pro**  Fig. 1 Source: https://www.oneplus.com/8-pro/specs, Page 1, Last Accessed 18th Aug, 2020, Exhibit A

	adaptation of transmissions over the downlink radio channel 33. [Col.6, line 51-53] **Adapting the data transmission to the state of the channel** is often referred to as **link adaptation.** [Col.1, line 22-23]	**Citation 2: OnePlus 8 Pro Specifications**  Fig. 2 Source: https://www.oneplus.com/8-pro/specs, Page 2, Last Accessed 18th Aug, 2020, Exhibit A **Citation 3: OnePlus 8 Specifications**  Fig. 3 Source: https://www.oneplus.com/8?from=head, Page 7, Last Accessed 18th Aug, 2020, Exhibit B

		Qualcomm Snapdragon 865 processor along with X55 RF modem functions on the 3GPP release 15 specifications of 5G technology such as Multi-Edge LDPC, and CRC-Aided Polar coding scheme. RF modem uses Advanced Channel coding technology such as polar coding scheme (support large data blocks and reliable control channel) for transmitting channel information from User Equipment (UE) to Base Station as shown in Fig. 4. **Citation 4: Advanced channel Coding Scheme in 5G Processor**  Fig. 4 Source: https://www.qualcomm.com/media/documents/files/making-5g-nr-a-commercial-reality.pdf, Page 13, Last Accessed on 18th Aug, 2020, Exhibit C According to the 3GPP standard, TS 38.212 (i.e. shown in Fig. 5) Uplink control information (UCI) uses Physical Uplink Control Channel (PUCCH), Physical Uplink Shared Channel (PUSCH) for the transmission of channel information which consists of Channel Quality Index (CQI), Precoding Matrix Index (PMI) and Rank Indicator (RI) for link adaptation as shown in Fig. 6.

Citation 5: Physical Channel and Control Information

Table 4.1-2

Control information	Physical Channel
UCI	PUCCH, PUSCH

Table 5.3-2: Usage of channel coding scheme for control information

Control Information	Coding scheme
DCI	Polar code
UCI	Block code
	Polar code

Fig. 5

Source:https://www.etsi.org/deliver/etsi_ts/138200_138299/138212/15.08.00_60/ts_138212v150800p.pdf, Page 10 and 13, Last Accessed on 18th Aug, 2020, Exhibit D

Citation 6: CSI reporting

5.2 UE procedure for reporting channel state information (CSI)

5.2.1 Channel state information framework

The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI) and/or L1-RSRP.

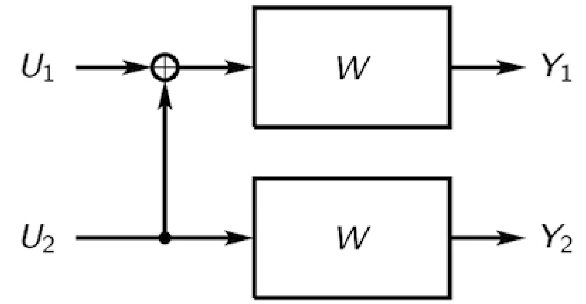
Fig. 6

Source:https://www.etsi.org/deliver/etsi_ts/138200_138299/138214/15.02.00_60/ts_138214v150200p.pdf, Page 1, Last accessed on 24th Aug, 2020, Exhibit E

		Link adaptation is the ability to adapt the various modulation schemes and the coding rate for the error correction according to the quality of the radio link which is sent by the UE to the base station in the form of CSI framework as referred in Fig. 7 & Fig. 8. **Citation 7: CSI framework** 5.2.1 Channel state information framework The time and frequency resources that can be used by the UE to report CSI are controlled by the gNB. CSI may consist of Channel Quality Indicator (CQI), precoding matrix indicator (PMI), CSI-RS resource indicator (CRI), SS/PBCH Block Resource indicator (SSBRI), layer indicator (LI), rank indicator (RI) and/or L1-RSRP. Fig. 7 Source: https://www.etsi.org/deliver/etsi_ts/138200_138299/138214/15.02.00_60/ts_138214v150200p.pdf , Page 31, Last Accessed on 18th Aug, 2020, Exhibit E **Citation 8: Link Adaptation according to 3GPP Standard** 5.2.5 Physical layer procedures 5.2.5.1 Link adaptation Link adaptation (AMC: adaptive modulation and coding) with various modulation schemes and channel coding rates is applied to the PDSCH. The same coding and modulation is applied to all groups of resource blocks belonging to the same L2 PDU scheduled to one user within one transmission duration and within a MIMO codeword. For channel state estimation purposes, the UE may be configured to measure CSI-RS and estimate the downlink channel state based on the CSI-RS measurements. The UE feeds the estimated channel state back to the gNB to be used in link adaptation. Fig. 8 Source: https://www.etsi.org/deliver/etsi_ts/138300_138399/138300/15.09.00_60/ts_138300v150900p.pdf , Page 22, Last Accessed on 18th Aug, 2020, Exhibit G

1a. encoding the channel information using multi-level coding, said multi-level coding comprising combining multiple bit sequences, each bit sequence corresponding to a coding level of said multi-level coding; and	When operating the network 11, channel information CI is encoded and/or modulated by the encoder 19. The **encoder 19 generates a signals that is transmitted over the uplink radio channel** 29 by the transmitter 21. The **signals may comprise a codeword c generated by the encoder 19 and comprising the channel information CI.** [Col.6, line 28-33] For **each coding level 0,..., n, the prioritizing element 37, generates a bit sequence** (c1, c2, ..., cn, d), **Each generated bit sequence c1 c2, ..., c, corresponds to the part ci, cil of channel information**	The method practised by the accused products comprises encoding the channel information using multi-level coding, said multi-level coding comprising combining multiple bit sequences, each bit sequence corresponding to a coding level of said multi-level coding; and OnePlus 8 series mobile devices that support Snapdragon X55 RF modem uses an advanced channel coding scheme, which is the combination of error detection, error-correcting, rate matching, interleaving, and transport channel or control information mapping onto/splitting from physical channels. (Refer Fig. 9). **Citation 9: Channel coding Scheme in 3GPP Standard** 5 General procedures Data and control streams from/to MAC layer are encoded /decoded to offer transport and control services over the radio transmission link. Channel coding scheme is a combination of error detection, error correcting, rate matching, interleaving and transport channel or control information mapping onto/splitting from physical channels. Fig. 9 Source: https://www.etsi.org/deliver/etsi_ts/138200_138299/138212/15.08.00_60/ts_138212v150800p.pdf , Page 10, Last Accessed on 18th Aug, 2020, Exhibit D Polar codes (i.e. multi-level coding) are one of the channel coding schemes which uses as the error-correcting code on the 5G NR control channels. Polar code has a unique feature of splitting the channel into good and bad bit-channels as shown in Fig. 10.

	CI to which the coding level of that bit sequence c1 c2, . . . , c, has been assigned. [Col.7, line 42-46] Preferably, **each coding level corresponds to a level of a detection probability of the bit sequence of that coding level.** The detection probability is the probability that the bit sequence is correctly detected by a receiver, provided that transmission errors may occur when transmitting the channel information over the radio channel. The method may be executed by a terminal of the wireless network. [Col.2, line 9-15]	**Citation 10: Polar Codes** 3GPP has selected polar codes as the error correcting code on the 5G NR control channels. Polar codes are unique in the way they split the channel into good and bad bit-channels. We will learn about the channel splitting by Fig. 10 Source: https://medium.com/5g-nr/polar-codes-703336e9f26b, Page 1, Last Accessed on 18th Aug, 2020, Exhibit H Polar code encoding polarizes the channel into reliable and unreliable bit-channels. The information bits will be transmitted on the most reliable channels and the rest of the bits are transmitted on unreliable channels. In general, each coding level is related to the level of detection probability (0.09, 0.51 etc.) for the bit sequence (u1, u2 etc). The detection probability is based on the receiver's level of decoding the bit sequence correctly as shown in Now let's turn our attention to the **W⁺** channel. The channel reconstructs the input received on the U2 channel. With a BEC channel, we have the following possibilities: • Both channels are successfully decoded — probability $\mathbf{(1\text{-}p)^2}$ • The first channel is erased but the second one is decoded successfully — probability **p(1-p)** • The first channel is decoded successfully but the second channel is erased — probability **(1-p)p** • Both channels are erased — probability $\mathbf{p^2}$ Fig. 11 and Fig. 12. **Citation 11: Probability Detection**



Connecting the two-channel as shown above polarizes the output

Now let's turn our attention to the **W^+** channel. The channel reconstructs the input received on the U2 channel. With a BEC channel, we have the following possibilities:

- Both channels are successfully decoded — probability **$(1\text{-}p)^2$**
- The first channel is erased but the second one is decoded successfully — probability **p(1-p)**
- The first channel is decoded successfully but the second channel is erased — probability **(1-p)p**
- Both channels are erased — probability **p^2**

Now let's turn our attention to the **W^+** channel. The channel reconstructs the input received on the U2 channel. With a BEC channel, we have the following possibilities:

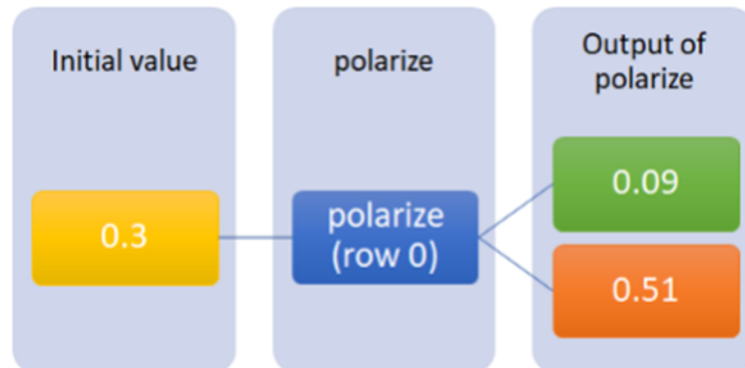
- Both channels are successfully decoded — probability **$(1\text{-}p)^2$**
- The first channel is erased but the second one is decoded successfully — probability **p(1-p)**
- The first channel is decoded successfully but the second channel is erased — probability **(1-p)p**
- Both channels are erased — probability **p^2**

Fig. 11

Source: https://medium.com/5g-nr/polar-codes-703336e9f26b, Page 2,3 and 4, Last accessed on 18th Aug, 2020, Exhibit H

Citation 12: Polarized script

The polarize script can be visualized as shown below.

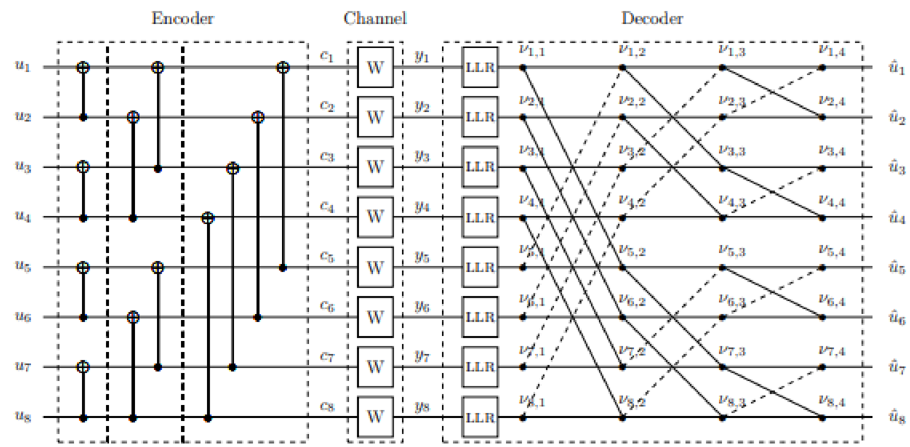


Visualization of the "polarize" script

Fig. 12

Source: https://medium.com/5g-nr/polar-codes-703336e9f26b, Page 8, Last accessed on 18th Aug, 2020, Exhibit H

In polar coding, the number of encoding levels corresponds to the number of information bits sequence (such as u1, u2 etc.). The total number of encoders in multilevel polar coding is equal to the number of bits in the sequence. For example, for 8-bit sequence (u1,u2....u8), there will be 8 encoding levels. So, the encoder will generate codeword (c1,c2 etc.) of the bit sequences as shown in Fig. 13.

		Citation 13: Polar Code Encoding Process The first part of Fig. 2.4 illustrates how a polar codeword with $N = 8$ by step-wise applying of polar transform $\mathbf{F}_p$ is constructed. Here, the information set and frozen set are $\{u_4, u_6, u_7, u_8\}$ and $\{u_1, u_2, u_3, u_5\}$, respectively. To encode the polar codes, the kernel (2.7) is applied in n consecutive steps to construct a codeword of length $N = 2^n$ and since in each step, each bit is involved in one operation, the total encoding complexity is of order $O(Nn)$ for implementation of $\mathbf{F}_p^{\otimes n}$ [1]. This low encoding complexity is, in fact, one of the advantages of polar  **Figure 2.4:** Polar encoder and decoder. Fig. 13 Source: [https://pdfs.semanticscholar.org/66a3/6dde3024c2af110bd33fccdc2872e620a6c2.pdf,](https://pdfs.semanticscholar.org/66a3/6dde3024c2af110bd33fccdc2872e620a6c2.pdf) Page 42, Last accessed on 24th Aug, 2020, Exhibit F

1b. assigning one of said coding levels to at least a part of the channel information such that the at least a part of the channel information corresponds to the bit sequence of that coding level; **1c.** wherein the method comprises subdividing the channel information into multiple parts of channel information according to an importance of parts of channel information for the link adaptation and assigning one of said coding levels to at least one part of said multiple parts.	the method comprises **assigning multiple coding levels to multiple parts of the channel information**, [Col.2, Line 44-45] **Choosing an appropriate coding level also allows to prioritise channel information of different relevance**. **For instance, a robust coding level (i.e., high detection rate) can be assigned to essential channel information while a less-robust coding level is chosen for channel information that is less important.** [Col.2, line 25-30] a **first part of said multiple parts of channel information comprises**	The accused produced practices, assigning one of said coding levels to at least a part of the channel information such that the at least a part of the channel information corresponds to the bit sequence of that coding level; OnePlus 8 series mobile devices with snapdragon 5G modem has polar encoding feature, Polar code encoding polarizes the channel into reliable (higher importance) and unreliable bit-channels (lower importance) based on detection probability. The information bits (such as u1) will be transmitted on the most reliable channels and the rest of the bits are transmitted on unreliable channels. Here every coding level is relating to the level of detection probability of the bit sequence. The probability of detection is based on the bit sequence that is correctly decoded by the receiver as shown in Fig. 14. **Citation 14: Probability Detection**

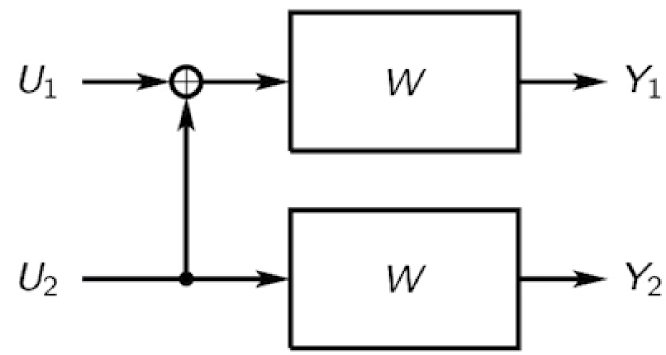
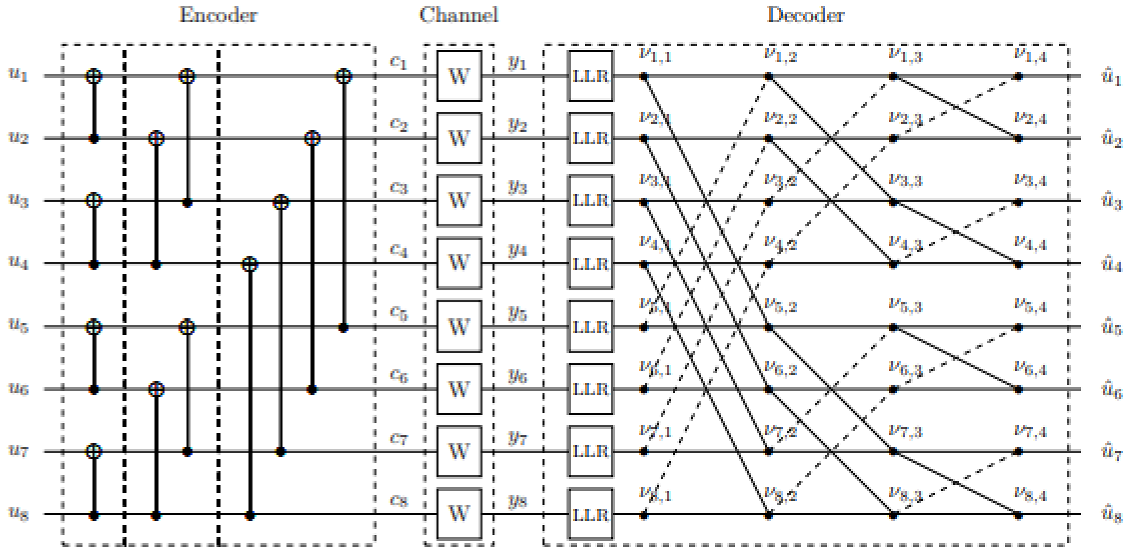
	wideband information related to the whole radio channel and a second part of said multiple parts of channel information comprises Sub-band information related to a sub-band of the radio channel, [Col.3, Line 16-20] **the parts of the channel information are prioritised by assigning to them different coding levels having different detection probability levels.** [Col.2, line 50-54]	 Connecting the two-channel as shown above polarizes the output The **W⁻** channel tries to reconstruct the input received on the U1 channel. The following possibilities exist when the W channel is modeled as a BEC: • Both channels are successfully decoded — probability **$(1\text{-}p)^2$** • The first channel is erased but the second one is decoded successfully — probability **p(1-p)** • The first channel is decoded successfully but the second channel is erased — probability **(1-p)p** • Both channels are erased — probability **p^2** Now let's turn our attention to the **W^+** channel. The channel reconstructs the input received on the U2 channel. With a BEC channel, we have the following possibilities: • Both channels are successfully decoded — probability **$(1\text{-}p)^2$** • The first channel is erased but the second one is decoded successfully — probability **p(1-p)** • The first channel is decoded successfully but the second channel is erased — probability **(1-p)p** • Both channels are erased — probability **p^2**

		Fig. 14 Sourcehttps://medium.com/5g-nr/polar-codes-703336e9f26b, Page 2,3 and 4, Last accessed on May 12, 2020, Exhibit H In polar coding, the number of encoding levels corresponds to the number of information bits sequence (such as u1, u2 etc.). The total number of encoders in multilevel polar coding is equal to the number of bits in the sequence. For example, for 8-bit sequence (u1,u2....u8), there will be 8 encoding levels. So, the encoder will generate codeword (c1,c2 etc.) of the bit sequences as shown in Fig. 15 and Fig. 16. **Citation 15: Polar Code Encoding Process**

		The first part of Fig. 2.4 illustrates how a polar codeword with $N = 8$ by step-wise applying of polar transform $\mathbf{F}_p$ is constructed. Here, the information set and frozen set are $\{u_4, u_6, u_7, u_8\}$ and $\{u_1, u_2, u_3, u_5\}$, respectively. To encode the polar codes, the kernel (2.7) is applied in n consecutive steps to construct a codeword of length $N = 2^n$ and since in each step, each bit is involved in one operation, the total encoding complexity is of order $O(Nn)$ for implementation of $\mathbf{F}_p^{\otimes n}$ [1]. This low encoding complexity is, in fact, one of the advantages of polar  **Figure 2.4:** Polar encoder and decoder. Fig. 15

Source: https://pdfs.semanticscholar.org/66a3/6dde3024c2af110bd33fccdc2872e620a6c2.pdf, Page 42, Last accessed on May 12, 2020, Exhibit F

Citation 16: Splitting and assignment of information bits to coding level (3GPP Standard)

5.3.1 Polar coding

The bit sequence input for a given code block to channel coding is denoted by $c_0, c_1, c_2, c_3, ..., c_{K-1}$, where K is the number of bits to encode. After encoding the bits are denoted by $d_0, d_1, d_2, ..., d_{N-1}$, where $N = 2^n$ and the value of n is determined by the following:

5.3.1.1 Interleaving

The bit sequence $c_0, c_1, c_2, c_3, ..., c_{K-1}$ is interleaved into bit sequence $c'_0, c'_1, c'_2, c'_3, ..., c'_{K-1}$ as follows:

$$c'_k = c_{\Pi(k)},\ k = 0,1,...,K-1$$

Fig. 16

Source:

https://www.etsi.org/deliver/etsi_ts/138200_138299/138212/15.08.00_60/ts_138212v150800p.pdf, Page 14 and 26, Last Accessed on 18th Aug, 2020, Exhibit D

The Channel information (i.e. CSI) can be divided into the multiple parts such as wideband band CSI and sub-bands CSI (i.e. subdividing the channel information). Wideband CSI always have the highest priority than the sub-bands. Wideband or sub bands CQI reporting, as configured by the higher layer parameter. Also, each UCI bit sequence is mapped (i.e. assigned) to the corresponding CSI report (i.e. a part of the channel information) as shown in Fig. 17 and Fig. 18.

Citation 17: Wideband and Sub-band CSI

		- wideband CQI or subband CQI reporting, as configured by the higher layer parameter *cqi-FormatIndicator*. When wideband CQI reporting is configured, a wideband CQI is reported for each codeword for the entire CSI reporting band. When subband CQI reporting is configured, one CQI for each codeword is reported for each subband in the CSI reporting band. **Table 5.2.3-1: Priority reporting levels for Part 2 CSI** Priority 0: Part 2 wideband CSI for CSI reports 1 to N_{Rep} Priority 1: Part 2 subband CSI of even subbands for CSI report 1 Priority 2: Part 2 subband CSI of odd subbands for CSI report 1 Priority 3: Part 2 subband CSI of even subbands for CSI report 2 Priority 4: Part 2 subband CSI of odd subbands for CSI report 2 ⋮ Priority $2N_{\text{Rep}}-1$: Part 2 subband CSI of even subbands for CSI report N_{Rep} Priority $2N_{\text{Rep}}$: Part 2 subband CSI of odd subbands for CSI report N_{Rep} Fig. 17 Source:https://www.etsi.org/deliver/etsi_ts/138200_138299/138214/15.02.00_60/ts_138214v150200p.pdf, Page 35 and 66, Last accessed on 24th Aug, 2020, Exhibit E **Citation 18: Mapping of CSI to UCI bit sequence (assignment)**

Table 6.3.1.1.2-14: Mapping order of CSI reports to UCI bit sequence $a_0^{(2)}, a_1^{(2)}, a_2^{(2)}, a_3^{(2)}, ..., a_{A^{(2)}-1}^{(2)}$, with two-part CSI report(s)

<table>
<tr><th>UCI bit sequence</th><th>CSI report number</th></tr>
<tr><td rowspan="8">$a_0^{(2)}$
$a_1^{(2)}$
$a_2^{(2)}$
$a_3^{(2)}$
$\vdots$
$a_{A^{(2)}-1}^{(2)}$</td><td>CSI report #1, CSI part 2 wideband, as in Table 6.3.1.1.2-10 if CSI part 2 exists for CSI report #1</td></tr>
<tr><td>CSI report #2, CSI part 2 wideband, as in Table 6.3.1.1.2-10 if CSI part 2 exists for CSI report #2</td></tr>
<tr><td>…</td></tr>
<tr><td>CSI report #n, CSI part 2 wideband, as in Table 6.3.1.1.2-10 if CSI part 2 exists for CSI report #n</td></tr>
<tr><td>CSI report #1, CSI part 2 subband, as in Table 6.3.1.1.2-11 if CSI part 2 exists for CSI report #1</td></tr>
<tr><td>CSI report #2, CSI part 2 subband, as in Table 6.3.1.1.2-11 if CSI part 2 exists for CSI report #2</td></tr>
<tr><td>…</td></tr>
<tr><td>CSI report #n, CSI part 2 subband, as in Table 6.3.1.1.2-11 if CSI part 2 exists for CSI report #n</td></tr>
</table>

Fig. 18

Source:https://www.etsi.org/deliver/etsi_ts/138200_138299/138212/15.08.00_60/ts_138212v150800p.pdf, Page 52, Last accessed on 24th Aug, 2020, Exhibit D

References Cited

Exhibit(s)	Description	Link
Exhibit A	OnePlus 8 Pro Specifications	https://www.oneplus.com/8-pro/specs
Exhibit B	OnePlus 8 Series	https://www.oneplus.com/8?from=head
Exhibit C	Qualcomm Document on 3GPP Release 15	https://www.qualcomm.com/media/documents/files/making-5g-nr-a-commercial-reality.pdf,
Exhibit D	3GPP Standard TS 38.212 V 15.8.0	https://www.etsi.org/deliver/etsi_ts/138200_138299/138212/15.08.00_60/ts_138212v150800p.pdf
Exhibit E	3GPP Standard TS 38.214 V 15.2.0	https://www.etsi.org/deliver/etsi_ts/138200_138299/138214/15.02.00_60/ts_138214v150200p.pdf
Exhibit F	Multi Level Polar coded Modulation	https://pdfs.semanticscholar.org/66a3/6dde3024c2af110bd33fccdc2872e620a6c2.pdf
Exhibit G	3GPP Standard TS 38.300 V 15.9.0	https://www.etsi.org/deliver/etsi_ts/138300_138399/138300/15.09.00_60/ts_138300v150900p.pdf
Exhibit H	Polar Codes	https://medium.com/5g-nr/polar-codes-703336e9f26b